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Problem-Based Learning On The Ability Of Concept Understanding And Problem Solving Students' Mathematics On Function Material Squares In Grade X

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Abstract

This study aims to determine the effect of problem-based learning on students' conceptual understanding and mathematical problem solving abilities on quadratic function material at SMK Negeri 5 Medan 2024/2025. The type of research used is quantitative descriptive. The research population was all class X, and the research sample consisted of 65 class X students. The sampling technique was carried out using purposive sampling technique. The instruments used were tests, questionnaires and observation sheets. Hypothesis testing in this study used t-test and descriptive test. The results of the study showed that: (1) problem-based learning has an effect on conceptual understanding abilities, (2) the magnitude of the influence of problem-based learning on students' conceptual understanding abilities is 89.2%, (3) problem-based learning has an effect on mathematical problem solving abilities, (4) the magnitude of the influence of problem-based learning on problem solving abilities is 69.0%, (5) problem-based learning on students' conceptual understanding abilities is effective, (6) problem-based learning on problem solving abilities are effective.

Keywords: *Learning, Problem-Based, Ability, Conceptual Understanding, Problem Solving*

INTRODUCTION

Mathematics can be a means of solving problems in everyday life to equip students' potential in logical, systematic, analytical, creative, critical, and collaborative thinking (Chandra & Rahman, 2021). Compared to other subjects, the proportion of time for mathematics subjects is more because mathematics is considered a scientific discipline that is the basis of scientific disciplines that are useful in the development of science and technology (Siregar, Mulyono, & Surya, 2023). Mathematics education aims as mathematics learning in schools, namely (1) so that students have the ability to understand mathematical concepts, explain the relationship between concepts and apply them flexibly, efficiently, accurately, and appropriately to solve problems, (2) so that students have the ability to solve

problems including understanding problems, compiling mathematical models, finding solutions, and interpreting solutions that have been obtained (Fitriyanti, Maasawet, & Boleng, 2021).

Mathematical understanding is the application of formulas or concepts in simple calculations, explanations of concepts according to their characteristics, transformation of information from one form to another and the correct association of one concept with another (Dyastanti, 2018). The results of the study showed that students experienced errors in solving problems stemming from a lack of conceptual understanding and an inability to analyze and solve problems (Swandewi, Gita, & Suarsana, 2019). The causes of this problem can be seen from several aspects including the results of student assignments and daily assessments that are less than satisfactory, students' attitudes in the learning process who prefer to reach out to friends and not pay attention to learning, students' interest in understanding the subject matter is still lacking, in addition when the teacher gives examples of problems that are quite difficult, students are not enthusiastic about solving them and have difficulty solving problems in solving mathematics on the quadratic function material (Wulandari, Dantes, & Antara, 2020).

Algebra is a part of mathematics and quadratic functions are algebraic material studied in class X of State Vocational High School 5 Medan according to the independent curriculum. Quadratic functions are characterized by a parabolic graph, which can open upwards or downwards depending on the sign of the coefficient (Fadilah Pane & Sugiharti, 2022). Quadratic functions are one of the materials that can hone students' high-level thinking skills as well as being one of the materials for preparing to study material at a higher level. The purpose of studying quadratic functions is that students are able to use the properties and rules about the roots of quadratic equations, discriminants, axes of symmetry, from the vertex of the quadratic function graph in problem solving and drawing quadratic function graphs (Harahap, Mushlihuddin, & Afifah, 2022).

However, students experience difficulties when solving problems and solving them, which results in low mathematical abilities. This is caused by students' low intellectual ability to absorb the subject matter being taught, emotional disturbances that are sometimes very difficult to understand, and a lack of learning motivation (Aprilia, Slameto, & Radia, 2018). Students' inability to understand and apply quadratic function material to the given problems, students' difficulties in calculating/operating quadratic function problems, and students' inability to recall formulas they have learned previously. Difficulties are caused by students being hampered in understanding concepts. According to Umairoh (Sholeh & Fahrurozi, 2021) students' difficulties in mathematics include difficulty remembering formulas, not understanding the meaning of mathematical symbols, and difficulty identifying and utilizing algorithms.

Achieving mathematics learning goals is not easy. In fact, teachers still struggle to convey concepts to students, resulting in many students being unable to solve problems quickly, accurately, and correctly. This leads to learning difficulties and low student learning outcomes (Utami & Dafit, 2021). This is because mathematics instruction in schools places more emphasis on memorizing formulas than understanding concepts.

Conceptual understanding and problem solving are the learning objectives of quadratic functions. Conceptual understanding is a mathematical learning outcome based on the aspects of remembering and understanding (Aisyah & Madio, 2021). Students face difficulties in solving various problems due to their immature conceptual understanding, students still feel confused and have difficulty determining which formula to use to solve a problem (Simamora, Simamora, & Dewi, 2022).. This is because students still have difficulty explaining the concepts they have learned in their own words because they only focus on the examples given.

A common problem is students' low ability to solve mathematical problems. Problems usually involve situations that encourage someone to solve a problem, but do not immediately know what to do to solve it. Problem solving is thinking with the direct goal of finding a solution to a particular problem (Lubur, 2021:7). According to Polya (1973) in Tambunan (Fitriani, Suryana, & Hamdu, 2018)there are four stages to problem solving, namely; (1) understand the problem, (2) devise a plan, (3) carry out the plan, (4) look back. The problem is caused by students having difficulty solving mathematical problems because they tend to memorize mathematical concepts and definitions without understanding the meaning of their contents.

This problem is important to research, because there is a relationship between the ability to understand the concept of quadratic functions and students' success in achieving mathematics learning goals, both in terms of understanding concepts, problem solving, and their application in everyday life (Pardede, D. L., Pardede, L., Siahaan, M., Alexander, I. J., & Sirait, 2024). students' success in learning more advanced mathematics material, and there is a relationship between the ability to solve quadratic function problems and students' critical, analytical, and creative thinking abilities.

Research is important because quadratic functions are the basis of algebra that can foster students' conceptual understanding and facilitate students in solving mathematical problems. If students do not understand the concept of quadratic functions well, it will cause learning difficulties in students which result in low student learning outcomes. To overcome various problems of students' lack of understanding and mathematical problem-solving abilities, learning is needed that can overcome the difficulties of teachers in implementing teaching and students' difficulties in learning. One learning that is able to overcome this problem in mathematics learning is problem-based learning, namely a series of processes and steps in the approach in learning that starts from problems related to the material being studied by students to be asked to find the problems they face (Asmara & Sari, 2021).

According to George Polya (1973) in Tambunan (Arief, Zarory, Jufrizel, & Mursyitah, 2024) that "The abilities contained in mathematics can enable students to solve problems by thinking critically, logically and systematically, as well as in a structured manner, both mathematical problems and everyday problems". The benefits of problem-based learning are: (1) Students better understand the concepts taught because they discover them themselves; (2) Involves active problem solving and requires high-level thinking skills from students; (3) Students can feel the benefits of learning because the problems they solve are directly related to real life.

Problem-based learning is expected to enable students to overcome difficulties in learning mathematics and find their own solutions to problems in the material they are working on (Meriza, Mulbasri, & Nurhayati, 2023). Problem-based learning can improve student learning outcomes and mathematical understanding, which implies greater understanding, independence in learning, and the ability to solve mathematical problems. Furthermore, (Polya) states the need to provide guidance (heuristics) in the form of questions and useful directions at each stage of problem-solving, so that problems can be resolved easily.

Based on the description above, the researcher will conduct a research entitled Problem-Based Learning on Students' Mathematical Concept Understanding and Problem Solving Ability on Quadratic Function Material in Class X of SMK Negeri 5 Medan in the 2024/2025 Academic Year.

RESEARCH METHODS

This research will be conducted in the 10th grade students of SMK Negeri 5 Medan, located on Jl. Timor No. 36, Gaharu Subdistrict, East Medan District, North Sumatra. The research will be conducted in the even semester of the 2025 academic year.

Population is a generalization area consisting of objects/subjects that have certain qualities and characteristics determined by the researcher to be studied and then conclusions drawn (Pramesti & Rini, 2019). Therefore, the population in this study is all class X students of SMK Negeri 5 Medan consisting of 11 classes totaling 390 people.

A sample is a portion or representative of the population being studied. In this sampling, each class in the population has an equal chance of being selected. Based on the research design, two classes were required to serve as samples. Purposive random sampling was used to select the sample. Therefore, two classes, totaling 65 individuals, were selected.

Research variables are different values of individuals or activities selected by researchers to be investigated and analyzed, with the aim of drawing conclusions. In this study, there are two variables measured, namely: The independent variable is the variable that causes the dependent variable to appear (Indriani & Imanuel, 2018).. The independent variable in this study is problem-based learning.

The dependent variable is a variable that results from the presence of the independent variable. The dependent variables in this study are conceptual understanding (Y_1) and problem-solving (Y_2) abilities.

The type of research used by the researcher was descriptive quantitative. The quantitative method is a method of collecting data using research instruments and analyzing data based on quantitative descriptive statistics with the aim of testing the hypotheses formulated.

Quantitative research is a method for testing certain theories by examining the relationship between variables measured by descriptive quantitative data analysis research instruments that aim to propose predetermined hypotheses. According to Creswell in. Creswell and Clarkstate that "Descriptive research aims to describe the phenomena that exist in a population. The purpose of this research is to describe variables without making

comparisons or connecting independent variables with dependent variables (Grahito Wicaksono, 2020).

Research design is the overall planning for answering research questions and anticipating any difficulties that may arise during the research process (Hasan & Andayani, 2025). Research design in problem-based learning, focusing on conceptual understanding and problem-solving skills, uses a one-shot case study design. This design can be used if the research involves a group receiving treatment and then observing the results.

RESULTS AND DISCUSSION

This research was conducted in the even semester from February 14, 2025 to March 27, 2025 in class X DPIB-1 and X DPIB-2 SMK Negeri 5 Medan Jl. Timor No. 36, Gaharu Village, East Medan District, North Sumatra. Before the test was used on the research sample, the questions were first tested to see the validity of the questions, the reliability of the questions, the level of difficulty of the questions, and the discriminating power of the questions. To test the feasibility of the questions to be used according to the indicators and learning objectives achieved (HASIBUAN, 2020).

Research Data Analysis Results

The data analysis used in this study was inferential and descriptive analysis. Inferential analysis was used to test the hypothesis formulated in chapter 2. Descriptive analysis was used to determine the effectiveness of problem-based learning on students' conceptual understanding and mathematical problem-solving abilities.

Test of Significance of Correlation Coefficient

Conceptual Understanding Ability

First Hypothesis Test

The t-test is used to test the first hypothesis, namely to determine whether problem-based learning influences students' mathematical concept understanding abilities. The t-test is conducted by making decisions H_0Rejected, H_aAccepted: If$t_{hitung} > t_{tabel}$ on $\alpha = 5\%$ the value $sig < 0{,}05$, there is an influence. Based on the results of the research data that have been calculated using *SPSS 25.0 for Windows* after being analyzed using the t-test, the results obtained are as in Table 4.25 as follows:

Table 1. Results of the t-Test of Conceptual Understanding Ability

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	56.771	4.325		13.126	.000
	X	.265	.114	.281	2.328	.023

a. Dependent Variable: pemahaman konsep

The table shows that the value of 13.126 > 2.328 indicates that problem-based learning significantly impacts students' mathematical conceptual understanding. Therefore, it can be concluded that problem-based learning influences students' conceptual understanding.

Problem Solving Skills

Second Hypothesis Test

The t-test is used to test the second hypothesis, namely to determine whether problem-based learning has an effect on students' mathematical problem-solving abilities. The t-test is conducted by making a decision: H_0Rejected or H_aAccepted: If$t_{hitung} > t_{tabel}$ on$\alpha = 5\%$ with the value $sig < 0{,}05$, there is an influence. Based on the results of the research data that have been calculated using *SPSS 25.0 for Windows* , after being analyzed using the t-test, the results obtained are as in Table as follows:

Table 2. Results of the t-Test for Problem Solving Ability Problem

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	55.981	4.563		12.267	.000
	X	.278	.120	.280	2.312	.024

a. Dependent Variable: pemecahan masalah

The table shows that the value of 12.267 > 2.312 indicates that problem-based learning significantly impacts students' problem-solving abilities. Therefore, it can be concluded that problem-based learning influences students' problem-solving abilities.

Discussion of Research Results

Problem-based learning influences conceptual understanding. This is consistent with research findings, which found that problem-based learning can influence mathematics education students' conceptual understanding. This will undoubtedly enhance students' understanding of the material presented because they will work on problems based on the material explained previously. Consistent with research, problem-based learning is a

learning method that uses problem-based learning methods, aimed at facilitating students' understanding of the theory presented.

Problem-based learning impacts students' problem-solving abilities. This is consistent with the research findings of Siahaan et al. (Fauziyah & Haryanto, 2024)that problem-based learning improves students' problem-solving abilities and learning outcomes. Problem-based learning trains students to work collaboratively in groups and improves problem-solving abilities. problem-based learning is effective for students' mathematics learning outcomes. Based on the research analysis, the effectiveness of problem-based learning on problem-solving abilities is categorized as high.

This study examines the effect of problem-based learning on students' mathematical conceptual understanding and problem-solving abilities. The results show that problem-based learning has a positive and significant effect on both variables. Problem-based learning has been shown to have a significant effect on students' mathematical conceptual understanding abilities, with a significant effect of 89.2%. This means that almost 90% of the increase in students' conceptual understanding abilities is associated with the application of problem-based learning. This shows that problem-based learning allows students to actively build conceptual understanding through the process of problem exploration. Problem-based learning has a positive and significant effect on students' mathematical problem-solving abilities with a significant effect 69,0%. Problem-based learning effectively trains students to analyze problems and test results. In addition, problem-based learning is considered effective for both conceptual understanding and problem-solving variables. This is indicated by effectiveness scores that are above the good category in indicators of systematic learning, student responses, and student activities. The effectiveness of problem-based learning can be attributed to a systematically designed and interesting learning process. Clear and caring teacher communication helps students to respond and student activities during learning show their enthusiasm in participating in problem-based learning. This indicates that problem-based learning. This shows that problem-based learning creates a positive learning environment and motivates students.

The results of this study indicate that the problem-based learning model is effective in improving students' conceptual understanding and mathematical problem-solving abilities. This success can be attributed to the characteristics of problem-based learning, which requires students to be actively involved in every stage of learning, from understanding the problem, developing strategies, to finding solutions (Sasoeng, Wonggo, & Liando, 2023). Students are not only required to memorize concepts or formulas, but also to understand and apply concepts in real-world contexts, so that the learning process becomes more meaningful. In this learning, students are guided to follow Polya's problem-solving steps: understanding the problem, planning a solution, implementing the plan, and reviewing the results obtained. In addition to improving cognitive abilities, problem-based learning also has a positive impact on the affective and psychomotor aspects, as seen in students' enthusiasm, participation, and courage in expressing opinions and asking questions.

CONCLUSION

Based on the results of research conducted in class X of SMK Negeri 5 Medan on the quadratic function material for the 2024/2025 academic year, the following conclusions are drawn:

1. Problem-based learning influences students' abilities in understanding mathematical concepts.
2. The large influence of problem-based learning on students' ability to understand mathematical concepts is 89.2%.
3. Problem-based learning influences students' abilities in solving mathematical problems.
4. The magnitude of the influence of problem-based learning on students' ability to solve mathematical problems is 69.0%.
5. Problem-based learning is effective in improving students' abilities in understanding mathematical concepts.
6. Problem-based learning is effective in improving students' mathematical problem-solving abilities.

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